



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

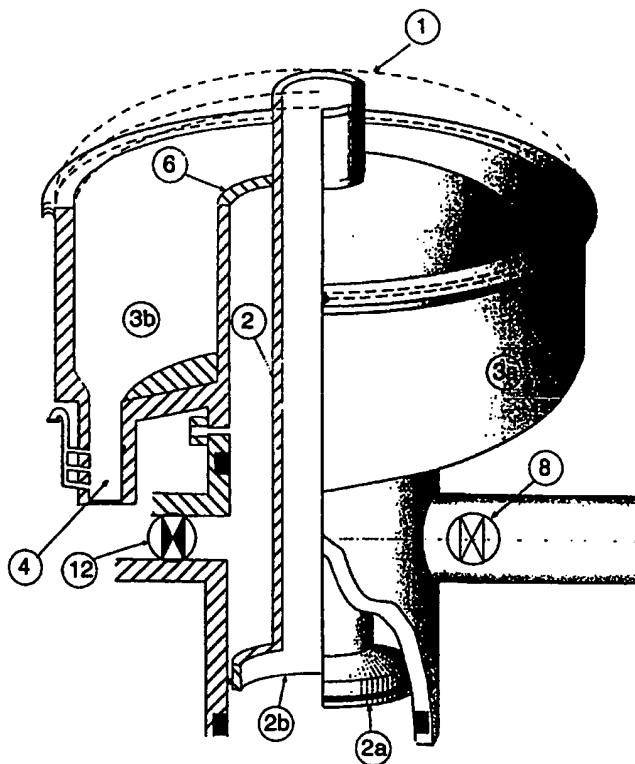
<b>(51) International Patent Classification <sup>6</sup>:</b> <b>E21B 43/34, B01D 21/00</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 99/20873</b> <b>(43) International Publication Date:</b> 29 April 1999 (29.04.99)
<b>(21) International Application Number:</b> PCT/NO98/00317 <b>(22) International Filing Date:</b> 22 October 1998 (22.10.98) <b>(30) Priority Data:</b> 974906 23 October 1997 (23.10.97) NO <b>(71) Applicant (for all designated States except US):</b> DEN NORSKE STATS OLJESELSKAP A.S [NO/NO]; N-4035 Stavanger (NO). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> GARNES, Jan, Magne [NO/NO]; Hoffmansv. 2, N-5035 Sandviken (NO). AN- DERSEN, Gunnar [NO/NO]; Stokkanveien 55B, N-7500 Stjørdal (NO). <b>(74) Agent:</b> ABC-PATENT, SIVILING. ROLF CHR. B. LARSEN A.S; Brynsveien 5, N-0667 Oslo (NO).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>With amended claims and statement.</i> <i>In English translation (filed in Norwegian).</i>

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(54) Title: SAND TRAP

## (57) Abstract

Device for separation of particles from a fluid-stream, especially for separating sand from a wellstream in petroleum production, in a tank with an inlet pipe and an outlet channel. The novel feature of the invention is that the inlet pipe has a mouth towards a relatively narrow part of the tank, with a spatial connection towards a relatively widened part of the tank, for precipitation of particles, with a sump arranged for the precipitated particles.



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**SAND TRAP**

This invention concerns a so-called sand trap, a device for separating particles from a fluid current, especially for separating sand from a wellstream in petroleum production, in a tank with an inlet and an outlet channel.

Oil bearing geological formation consisting loosely consolidated sandstones often bring much sand mixed up with the petroleum fluids produced by oilwells in the formation. Sand producing oilwells lead to erosion of surface equipment which may result in gas- or oil leaks, and may harm pumps and valves so they are worn or may fail. The remedy to the problem of sand production is to reduce the fluid flow out of the well. The Gullfaks field in the North Sea has, at the time of filing of the application, 39 wells producing at reduced rate due to sand production. One way of separating out sand is to apply a so-called sand cyclone. This is a cyclone separator which by means of the wellstream pressure and flow puts the petroleum fluid itself into a cyclonic movement at the inlet of a separating tank without moveable parts. Due to the centripetal forces arising and the different densities. Sand may be separated from the outer part of the cyclone inside the tank, and petroleum fluid from the inner part of the cyclone.

From patent publications several other kinds of sand traps not being of the cyclone kind are known. The applicant's own NO 176 451 describes a separate collecting tank for solid components and particles from an oil stream. This collection tank is arranged below a tank separating different liquids and gases from the wellstream. Vertical tubes connect the processing tank with the collecting tank. The collecting tank may be emptied, or changed with an empty tank.

US-patent 5 295 537 describes a particle trap which shall be arranged in an oil producing well. The oil stream is led over an inner standing cylinder-shaped edge and down through a perforated plate to a standing funnel. An outlet pipe reaches almost down to the lower inner outlet of the funnel. The oil passes up through the outlet pipe, while the particles fall down through the funnel to a closed

compartment. No other means for emptying the sand trap while full is devised, than pulling it out of the well and exchanging it.

5 The invention overcomes the disadvantages of the known art by devising a device for separation of particles from a fluid stream, especially for separating sand from a wellstream in petroleum production, in a tank with an inlet and an outlet.

10 The novel feature of the invention is primarily that the inlet has a mouth towards a relatively narrowed part of the tank, and that there is a spatial connection towards a relatively expanded part of the tank for precipitation of particles, with a sump arranged for the precipitated particles.

15 Further features of the invention arises from the subordinate claims.

The advantages of the invention is that one may perform petroleum production from a sand-bearing reservoir with a considerably reduced amount of particles in the produced  
20 petroleum fluid. It will also be possible to have a permanent connection without the use of provisional flow pipes. Further, it is an advantage that the main effect of the erosion occurs controlled in an area near the top of the particle trap. An additional advantage is that the preferred  
25 embodiment extends mainly in the height and is not especially space demanding, and that all well maintenance may be done without complete dismantling of the particle trap.

Below follows illustrations of a preferred embodiment  
30 of the invention. It will be explained in detail with reference to the following figure drawings.

Fig. 1 shows a vertical section of a principal embodiment of the invention.

35 Fig. 2 shows a vertical section of a preferred embodiment of the invention.

Fig. 3 shows a horizontal section through the plane A-A' of Fig. 2.

Fig. 4 is a perspective, partial section and partial view of the preferred embodiment of the invention.

40 Fig. 1 shows the main features of a principal

embodiment of the invention, where oil is meant to flow into a tank 1 vertically upwards through an inlet pipe 2. The inlet pipe has its mouth towards a relatively narrow area or space volume part 3a of the tank 1, and is led further, along the outer wall towards a relatively widened area or space volume part 3b where particles will precipitate to a sump 4 near the relatively expanded area or space volume part 3b. The oil will pass out over a threshold 6 and leave the tank through an outlet 7.

In a preferred embodiment the tank 1 is mainly of a vertical cylindrical shape with a convex top. The top makes, in a preferred embodiment, a unit together with the inlet pipe 2, preferably being fixed to the upper edge of the cylindrical sidewall of the tank by means of a flange connection 14 as shown in Fig. 2. This gives access to the well from above by unlocking the top from the flange connection and then removing the top and the inlet pipe 2 with a corresponding skirt 2b simultaneously. This solution makes logging, maintenance and all other well operations possible after arranging the particle trap 1 on the wellhead 10.

The inlet pipe 2 has a mouth pointing towards the wall in one side of the tank 1, preferably over a convexly arched surface which partly follows the convex shape of the top, and with the mouth pointing towards the side of the tank 1 towards the relatively narrow area 3a of the tank 1, and being closed on its lower side towards the outlet 7. A bottom 5a of the tank 1 is in a preferred embodiment more shallow under the relatively narrow area or space volume part 3a, and the bottom 5a is continuously inclined down towards and corresponding with a bottom 5b under the relatively expanded area or space volume part 3b of the tank 1.

A sump 4 constitutes in a preferred embodiment a unit in the bottom of the relatively expanded area or space volume part 3b, and has a device 4b for draining sedimented particles out of the swamp 4. This device may transfer the sedimented particle contents to an other tank or a pipe (not shown) for further treatment or separation of the particle-filled oil mud. In the preferred embodiment a valve 4c is

arranged above the draining device 4b, which valve 4c is arranged to isolate the petroleum fluids with the sedimented particle contents in the sump 4 from the petroleum fluids in the separation tank while the sump 4 is emptied. A valve 4d  
5 arranged at the bottom of the sump 4, the valve 4d is arranged for emptying the sump 4 to the sea or elsewhere.

The inlet pipe's 2 axis coincides, out of space considerations, generally with the axis of the tank 1. In alternative embodiments the axis of the inlet pipe may be  
10 parallel with the axis of the tank 1 and parallelly displaced with respect to that, towards the direction of the relatively restricted area or space volume part 3b. However such a solution is more demanding of space and will lay bonds on a potentially larger area around the wellhead if no  
15 special mounting azimuth direction on the wellhead is to be predetermined.

In a preferred embodiment, the spatial link between the relatively narrow area or space volume part 3a extends around the outer wall of the inlet pipe 2 to the relatively  
20 expanded or widened area or space volume part 3b. This connection occurs in the preferred embodiment on both sides about the inlet pipe 2. Alternatively the spatial connection between 3a and 3b be in only one direction about the inlet pipe 2. Preferably the mouth of the inlet pipe 2 is near the  
25 top of the tank 1.

An overflow or threshold 6 is arranged standing above the outlet channel 7. The petroleum fluids must pass this way out after the possible sedimentation of particles has taken place in the expanded space volume part 3b of the sump  
30 4.

The outlet channel 7 is limited outwards by the threshold 6 and the wellhead's 10 inner wall, and inwards by the outside of the inlet pipe's 2 outside, the inlet pipe having smaller diameter than the inner diameter of the  
35 wellhead 10. Below the outlet channel 7 is limited by a skirt 2b which by means of a packer 2a is closed against the inside of the wellhead 10, and arranged downstream with respect to an outlet valve or wing valve 8 at the side of the wellhead 10. The petroleum fluids, usually a mix of oil,  
40 gas and water will due to this arrangement flow out of the

wing valve above the skirt 2b in the same way as they do in the known art without the particle separator. Usually a kill-valve 12 is arranged at the same level of the wellhead as the wing valve 8. When a potential or existing too high pressure in the well is to be stopped, mud with high density is pumped in via the kill-valve 12 to the well, overcoming the overpressure in the well by means of the pressure from the heavy mud's hydrostatic column.

Below the skirt 2b there is usually arranged a master valve 13. This master valve closes off the whole wellhead towards the surroundings and is used while the particle trap is mounted on the wellhead. The particle trap has under the bottom 5a, 5b an outside continuation of the standing threshold 6, also constituting a part of the outlet channel 7, continuing to the wellhead 10. At the lower end of the outlet channel 7 is arranged a flange 15 fitting the top flange 16 of the wellhead. Over the master valve and the outlets to the kill- and wing valves 12, 8 there usually is arranged a swab valve 18. Before mounting the particle trap the swab valve 18 and the master valve 13 are closed, together with the wing valve 8. Then the top of the wellhead over the top flange 16 is removed, before the inlet pipe 2 with the skirt 2b is guided down into the wellhead until the flanges 15 and 16 meet. After the mounting of the particle trap by means of the flange connection 15, 16 the master valve and the wing valve is reopened for through flow of the petroleum fluid. The swab valve can not be operated when the particle trap is mounted, but Norwegian authorities' demand for two separate intact barriers is kept because the master valve 13 comprises the first barrier, and the particle trap together with the wing valve 8 and the kill valve 12 constitutes the other barrier.

The preferred embodiment is in a preferred embodiment designed for use on a so-called "platform well" but may with minor modifications be used on a wellhead at the seabed.

By means of one or more wall thickness metres, of the acoustic type or others, one may check that the erosion due to sand particles are within acceptable limits.

Clearly the invention is not limited to the described modification. The particle trap may be arranged with

additional construction features, e.g. with a detector or level gauge for sand particles in the sump 4, without departing significantly from the invention.

An additional development is to utilize a hydro cyclone in connection with the particle trap 1. After separation of sand particles in the particle trap 1 the petroleum fluid is guided via the wing valve and further to a hydrocyclone where oil and water is separated. However, such a hydrocyclone is of such great dimensions that it may  
10 difficultly be arranged by the wing valve, and it demands provisional connection pipes. An alternative is to integrate a hydrocyclone in an embodiment of the present invention so that the resulting sand-free petroleum fluid flow still, according to the invention, passes down through the outlet  
15 channel 7.



## C l a i m s

1. Device for separating particles from a fluid flow, especially for separating sand from a wellstream in petroleum production, in a tank (1) with an inlet (2) and an outlet (7),

c h a r a c t e r i z e d i n

that the inlet pipe (2) has a mouth toward a narrow area or space volume part (3a) of the tank (1), and that there is spatial connection further towards a relatively widened area or space volume part (3b) of the tank (1), arranged for precipitation of particles, with a sump (4) arranged for collecting the precipitated particles.

2. Device according to claim 1,

c h a r a c t e r i z e d i n

that the tank (1) is mainly vertically cylindrically shaped, and with a preferably convex top.

3. Device according to claim 2,

c h a r a c t e r i z e d i n

that the inlet pipe (2) has a mouth preferably towards a side wall by the relatively narrow area or space volume part (3a) of the tank (1).

4. Device according to one of the preceding claims,

c h a r a c t e r i z e d i n

that the relatively narrow area or space volume part (3a) and the relatively widened area (3b) is limited below of a generally inclined bottom (5a,5b) being deeper under the widened area or space volume part (3b) than under the relatively narrow area or space volume part (3a).

5. Device according to one of the preceding claims,

c h a r a c t e r i z e d i n

that the sump (4) is arranged in the bottom (5b) of the relatively widened area (3b) and has a device for draining particles out of the sump (4).

6. Device according to claim 5,

characterized in  
that the sump (4) comprises a valve (4c) for isolating parts  
of the sump from the relatively widened area (3b).

7. Device according to claim 5,  
characterized in  
that the bottom of the sump (4) comprises a valve (4d)  
arranged for emptying the sump (4).

8. Device according to one of the preceding claims,  
characterized in  
that the axis of the inlet pipe (2) is generally coincident  
with the axis of the tank (1).

9. Device according to claim 8,  
characterized in  
that the spatial connection from the relatively narrow area  
(3a) to the relatively widened area (3b) passes around the  
inlet pipe (2).

10. Device according to one of the preceding claims,  
characterized in  
that the mouth of the inlet pipe (2) is situated near the top  
of the tank (1).

11. Device according to one of the preceding claims,  
characterized in  
that the relatively wide area or space volume part (3b) has  
an overflow or threshold (6) arranged in such a way that the  
fluid on its way out must pass over the overflow or threshold  
(6).

12. Device according to one of the preceding claims,  
characterized in  
that the outlet channel (7) has, preferably but not  
necessarily, a circular cross-section.

13. Device according to one of the preceding claims,  
characterized in  
that the outlet channel (7) is outwardly limited by the

overflow (6) and the inner wall of the wellhead (10), and inwardly limited by the inlet channel (2) having an outer diameter less than the wellhead's (10) inner diameter, and downwardly limited by a skirt (2b) which is tight towards the inside of the wellhead, and arranged downstream with respect to a wing valve (8) of the wellhead (10).

14. Device according to claim 13,  
c h a r a c t e r i z e d i n  
that the skirt (2b) has a packer (2a) towards the inner side of the wellhead.

15. Device according to claim 13 or 14,  
c h a r a c t e r i z e d i n  
that the skirt is arranged downstream with respect to a kill-valve which is arranged preferably in the same pipe level of the wellhead as the wing valve (8).

16. Device according to claim 13, 14 or 15,  
c h a r a c t e r i z e d i n  
that the skirt (2b) is arranged immediately downstream with respect to a master valve (13).

## AMENDED CLAIMS

[received by the International Bureau on 22 March 1999 (22.03.99);  
original claims 1-16 replaced by amended claims 1-15 (3 pages)]

1. Device for separating particles from a fluid flow by expansion, especially for separating sand from a wellstream at a wellhead (10), comprising a tank (1) with an inlet (2) with a mouth towards a relatively narrow flow channel cross-section part (3a) of the tank (1), with further spatial connection towards a relatively widened flow channel cross-section part (3b) of the tank, arranged for precipitation of particles, with a sump (4) arranged for collecting the precipitated particles, and an outlet channel (7),  
c h a r a c t e r i z e d i n  
that the outlet channel (7) is arranged to conduct the petroleum fluid flow back via the wellhead (10) to leave the wellhead via a wellhead wing valve (8) in that the outlet channel (7) being outwardly limited by the inner wall of the wellhead (10), and being inwardly limited by the inlet pipe (2) with outer diameter smaller than the wellhead's (10) inner diameter, and downwardly limited by a skirt (2b) closing against the inner side of the wellhead (10), with the skirt (2b) is arranged for being placed upstream with the respect to the wing valve (8) in the wellhead (10).
2. Device according to claim 1,  
c h a r a c t e r i z e d i n  
that the sump (4) is arranged in the bottom (5b) of the relatively widened area (3b) and has a device for draining particles out of the sump (4).
3. Device according to claim 2,  
c h a r a c t e r i z e d i n  
that the sump (4) comprises a valve (4c) for isolating parts of the sump from the relatively widened flow channel cross-section part (3b) of the tank.
4. Device according to claim 2,  
c h a r a c t e r i z e d i n  
that the bottom of the sump (4) comprises a valve (4d) arranged for emptying the sump (4).

5. Device according to claim 1,  
c h a r a c t e r i z e d i n  
that the tank (1) is mainly vertically cylindrically shaped,  
and has a preferably convex top.
- 5 6. Device according to claim 5,  
c h a r a c t e r i z e d i n  
that the inlet pipe (2) has a mouth preferably towards a  
side wall by the relatively narrow flow channel cross-  
section part (3a) of the tank (1).
- 10 7. Device according to one of the preceding claims,  
c h a r a c t e r i z e d i n  
that the relatively narrow flow channel cross-section part  
(3a) and the relatively widened flow channel cross-section  
part (3b) of the tank is limited downwards by a generally  
15 inclined bottom (5a,5b) being deeper under the widened flow  
channel cross-section part (3b) than under the relatively  
narrow flow channel cross-section part (3a).
8. Device according to one of the preceding claims,  
c h a r a c t e r i z e d i n  
20 that the axis of the inlet pipe (2) is generally coincident  
with the axis of the tank (1).
9. Device according to claim 8,  
c h a r a c t e r i z e d i n  
that the spatial connection from the relatively narrow flow  
25 channel cross-section part (3a) to the relatively widened  
flow channel cross-section part (3b) passes around the inlet  
pipe (2).
10. Device according to one of the preceding claims,  
c h a r a c t e r i z e d i n  
30 that the mouth of the inlet pipe (2) is situated near the  
top of the tank (1).
11. Device according to one of the preceding claims,  
c h a r a c t e r i z e d i n  
that the relatively wide flow channel cross-section part

(3b) has an overflow or threshold (6) arranged in such a way that the fluid on its way out must pass over the overflow or threshold (6).

12. Device according to one of the preceding claims,  
5 c h a r a c t e r i z e d i n  
that the outlet channel (7) has a circular cross-section.

13. Device according to claim 1,  
c h a r a c t e r i z e d i n  
that the skirt (2b) has a packer (2a) towards the inner side  
10 of the wellhead.

14. Device according to claim 1 or 13,  
c h a r a c t e r i z e d i n  
that the skirt is arranged upstream with respect to a kill-  
valve which is arranged preferably in the same pipe level of  
15 the wellhead as the wing valve (8).

15. Device according to claim 1, 13 or 14,  
c h a r a c t e r i z e d i n  
that the skirt (2b) is arranged immediately downstream with  
respect to a master valve (13).

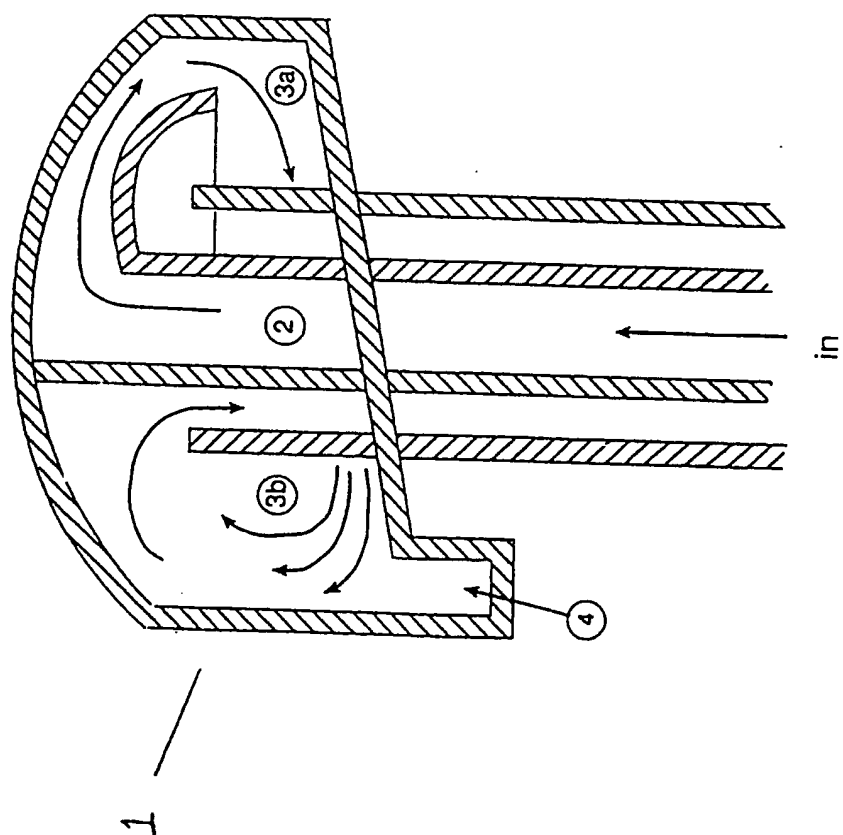
**Statement under article 19 (1), reasons for amendment of claims.**

Claim 1: The previous characterization now has been taken into the preamble to define the known art, especially US-patent 5 295 537 mentioned as the known art in the application, and US 4 357 244 from the international search report. As the search report does not mention sand separating devices for petroleum producing wellheads, the amended claim 1's preamble defines the device for separating sand from a wellstream at a wellhead. The characterizing features of claim 1 is concentrated around the unique way the connecting piping and skirt of the sand separator is arranged on the wellhead in order to returning the petroleum fluid flow back to the wellhead and leaving the normal way through the wing valve. This feature was previously defined in claim 13 which now constitutes a part of claim 1.

US 4 357 244 is not arranged for use on a wellhead, but there occurs a certain expansion of the fluid flow cross-section after the inlet. Sand is not the primary concern, but microscopic coal fragments. Agglomeration chemicals must be added for the embodiment to function properly. There is no mention of returning the fluid flow via the same wellhead using the same wing valve. More than one fluid is involved.

US 5 505 860 "Grease and Oil Trap", does not expand the fluid flow, and the embodiment is not made for a wellhead. There is no device for removing particles, exemplified as "food particles", and there is arranged a grease retainer baffle for removing grease from the fluid flow mainly comprising water.

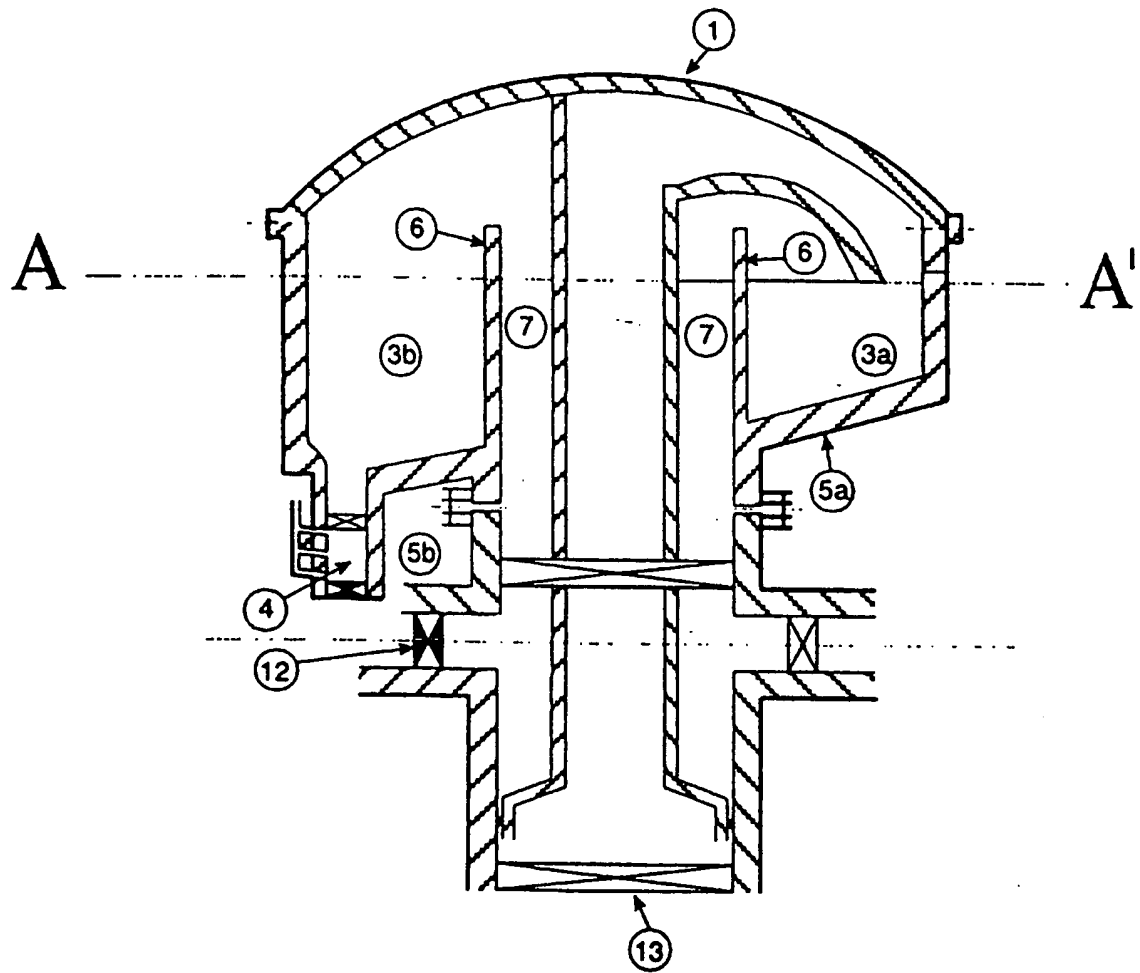
PCT/GB94/01311 "Separating liquid suspensions" is for water purification and is not closed so it cannot be used on a wellhead. Either does it return the purified fluid flow centrally. The same applies to GB 2 293 988.

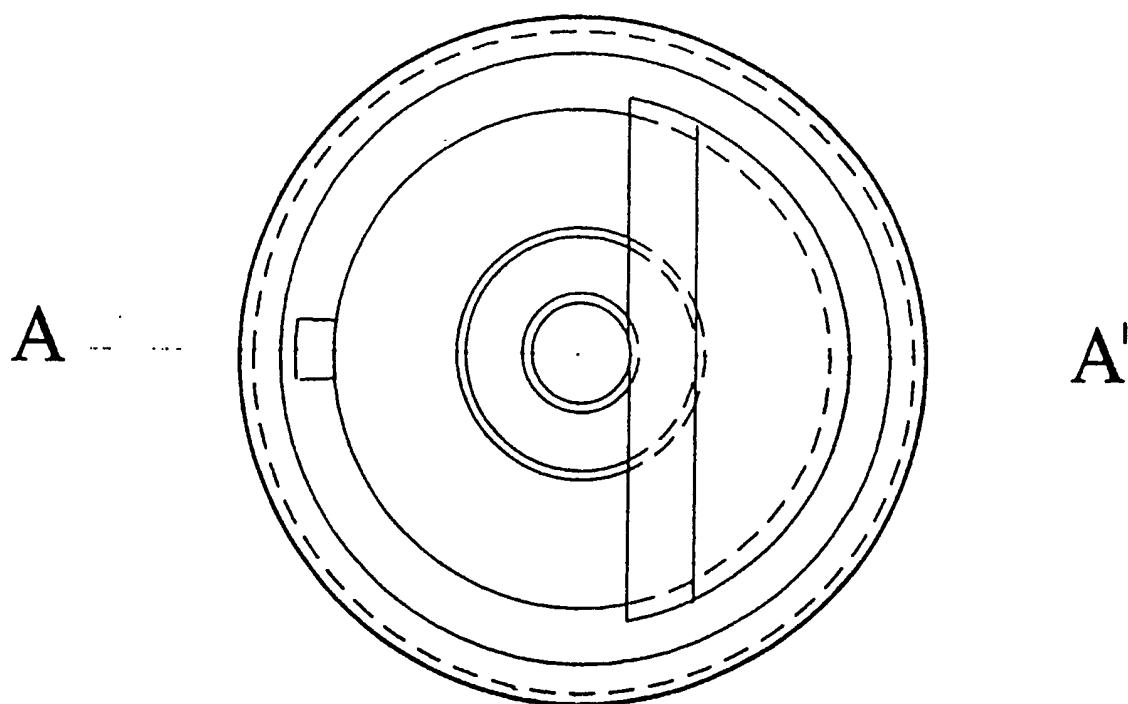


*Fig. 1*

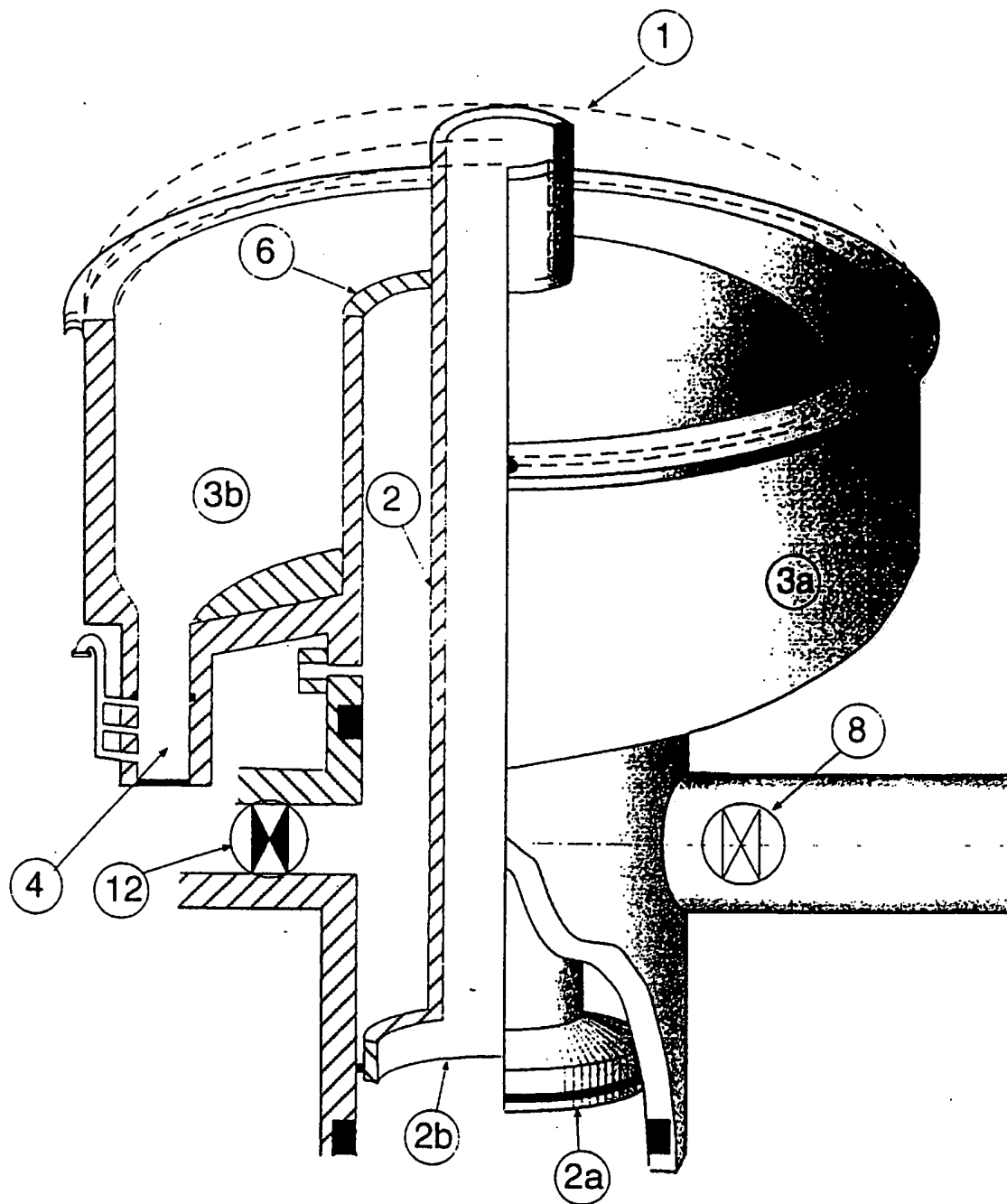


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*Fig. 2*



*Fig. 3*

**Fig. 4**

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 98/00317

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
IPC6: E21B 43/34, B01D 21/00 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: E21B, B01D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPODOC, WPI		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4357244 A (P.R. BOSE), 2 November 1982 (02.11.82), column 5 - column 6, figures 1,3	1-9,12
A	--	13-16
X	WO 9501215 A1 (SOUTHERN WATER SERVICE LTD.), 12 January 1995 (12.01.95), page 4 - page 5, figure 1	1-12
A	--	13-16
X	US 5505860 A (R.J. SAGER), 9 April 1996 (09.04.96)	1
A	--	2-16
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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Date of the actual completion of the international search		Date of mailing of the international search report
15 January 1999		20 -01- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer  Christer Bäcknert Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 98/00317

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2293988 A (UNIVERSITY OF BRISTOL), 17 April 1996 (17.04.96)  -- -----	1-16

## INTERNATIONAL SEARCH REPORT

Information on patent family members

01/12/98

International application No.

PCT/NO 98/00317

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		ZA 7903003 A	25/06/80
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WO 9501215 A1	12/01/95	AT 165996 T	15/05/98
		AU 672914 B	17/10/96
		AU 6975194 A	24/01/95
		CA 2141949 A	12/01/95
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